

AD-A064 004

D'APPOLONIA CONSULTING ENGINEERS PITTSBURGH PA
NATIONAL DAM INSPECTION PROGRAM. BRUSH MOUNTAIN DAM (NDI 539), --ETC(U)
JUL 78

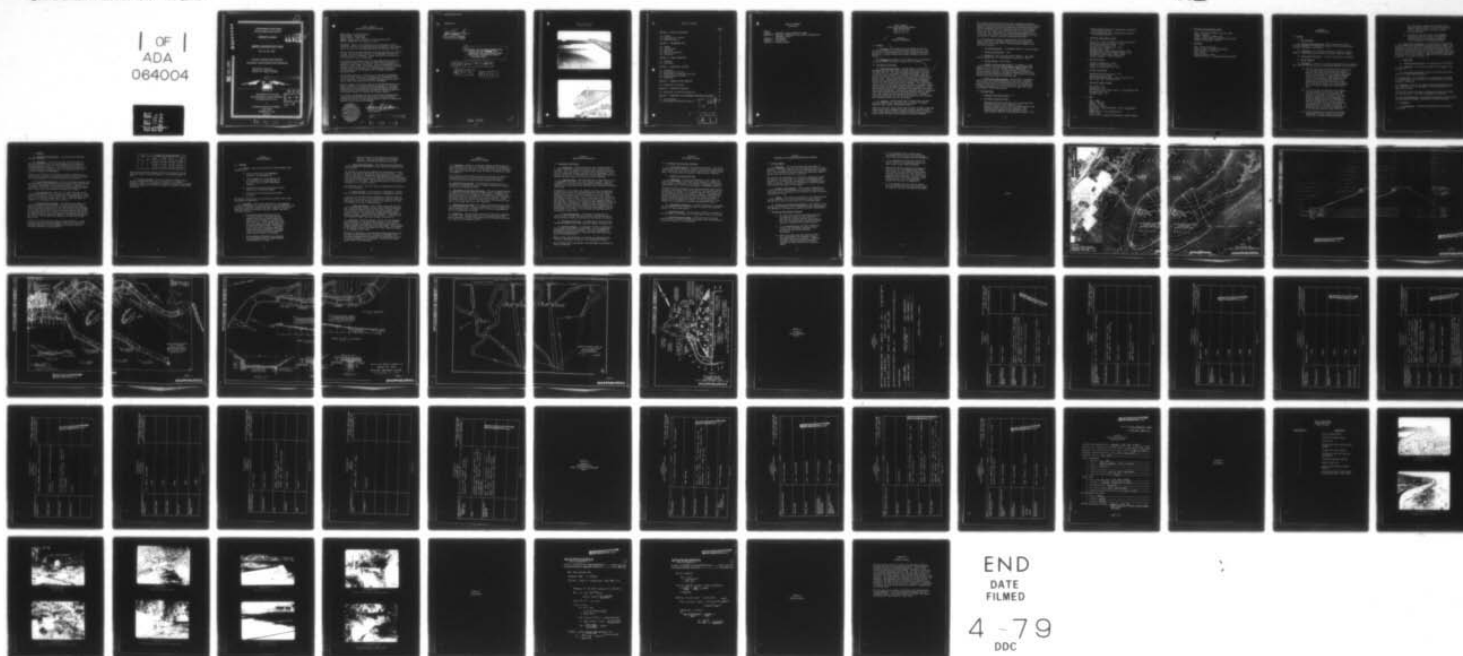
F/G 13/2

DACW31-78-C-0049

NL

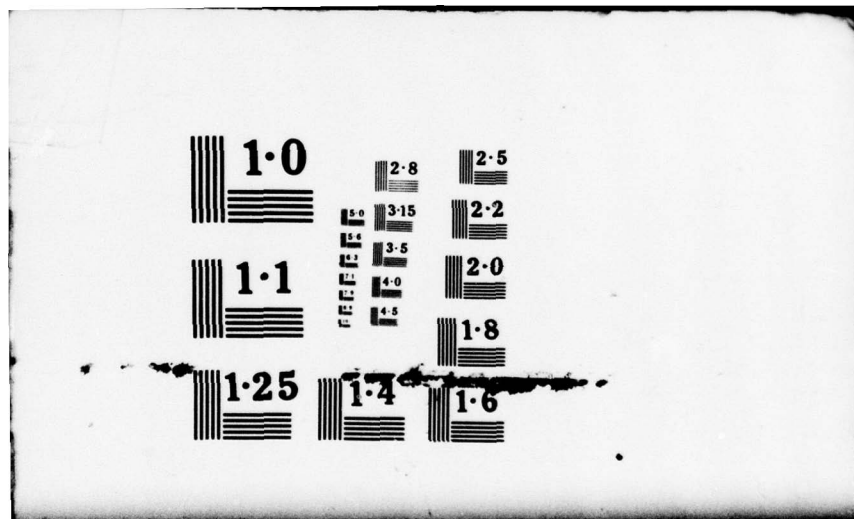
UNCLASSIFIED

1 OF 1
ADA
064004



END
DATE
FILMED

4 -79
DDC



AD A064004

DDC FILE COPY

SUSQUEHANNA RIVER BASIN
KETTLE CREEK, BLAIR COUNTY

PENNSYLVANIA

LEVEL

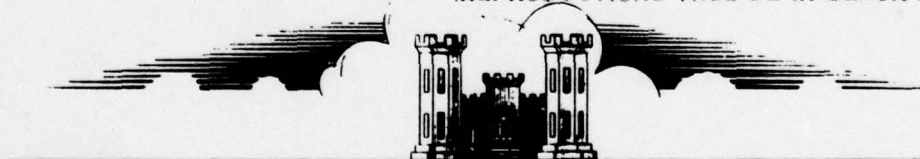
BRUSH MOUNTAIN DAM

NDI I.D. NO: 539

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Distribution Unlimited
Approved for Public Release
Contract No. DACW31-78-C-0049

ORIGINAL CONTAINS COLOR PLATES; ALL DDC
REPRODUCTIONS WILL BE IN BLACK AND WHITE



PREPARED FOR

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS
BALTIMORE, MARYLAND 21203

BY

D'APPOLONIA CONSULTING ENGINEERS

10 DUFF ROAD
PITTSBURGH, PA. 15235

JULY 1978

DDC

FEB 1 1979

A

79 01 29 118

76

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

NAME OF DAM: Brush Mountain Dam
STATE LOCATED: Pennsylvania
COUNTY LOCATED: Blair County
STREAM: Kettle Creek, tributary of Little Juniata River
DATE OF INSPECTION: July 10 and 18, 1978

ASSESSMENT: Based on the evaluation of the conditions as they existed on the dates of inspection and as revealed by visual observations, the condition of Brush Mountain Dam is assessed to be fair.

However, because the owner declined to operate the blow-off valve for the dam, the operational condition of the drawdown facilities for the dam could not be assessed. Visual observations indicated that these facilities are not maintained.

It is therefore recommended that the owner immediately assess the functional condition of the operating facilities and adequately maintain all appurtenant facilities. Other recommendations include repairing riprap slides on the downstream face of the dam, repairing spillway channel and seepage weirs, monitoring and recording seepage quantities, and evaluating the structural integrity of the outlet works.

The spillway capacity is classified to be "seriously inadequate" (23 percent PMF), because it is estimated that overtopping would result in failure of the dam and damage potential would be significantly higher than would exist prior to overtopping.

However, because the spillway capacity was determined based on the Corps of Engineers' approximate analysis procedure, it is recommended that the owner reevaluate the spillway adequacy using more accurate analysis techniques and determine the nature and extent of improvements required to increase the spillway capacity.

It is further recommended that the owner provide around-the-clock surveillance during unusually heavy runoff to detect possible problems and develop a formal warning system to alert the downstream residents in the event of an emergency.



Lawrence D. Andersen

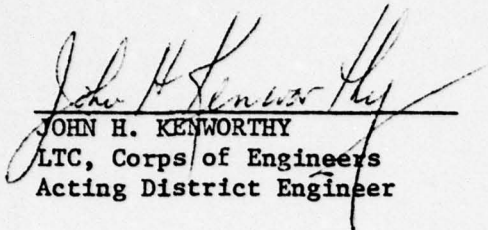
Lawrence D. Andersen, P.E.
Vice President

ORIGINAL CONTAINS COLOR PLATES: ALL DDC
1 REPRODUCTIONS WILL BE IN BLACK AND WHITE

79 01 29 118

Brush Mountain Dam

APPROVED BY:


JOHN H. KENWORTHY
LTC, Corps of Engineers
Acting District Engineer

6

National Dam Inspection Program, Brush Mountain Dam (NDI ~~15-539~~ 539), Susquehanna River Basin, Kettle Creek, Blair County, Pennsylvania, Phase I Inspection Report.

15

DAZW 31-78-C-0049

11

JUL 78

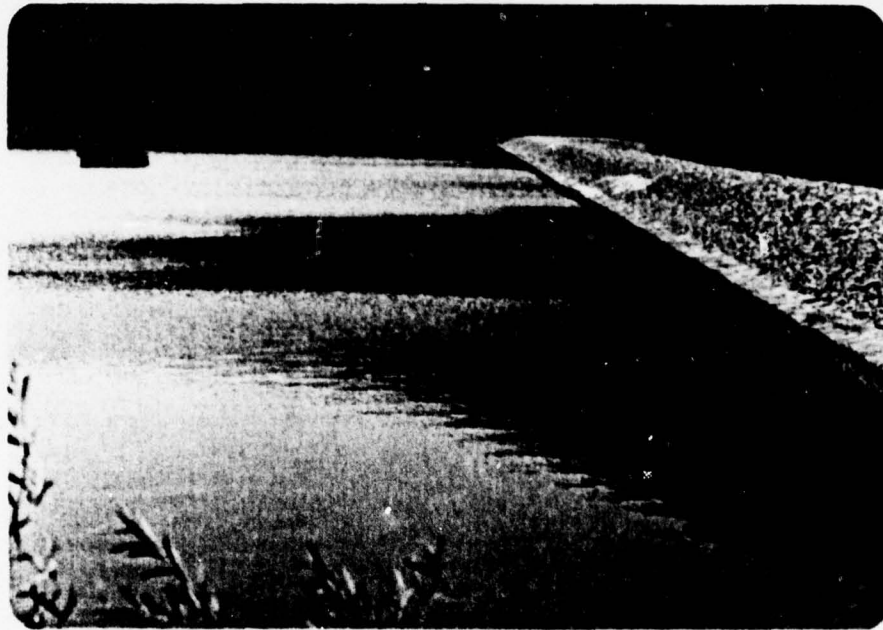
12

63 p1

411 002

alt

BRUSH MOUNTAIN DAM
JULY 10, 1978



Upstream Face



Downstream Face

TABLE OF CONTENTS

	<u>PAGE</u>
SECTION 1 - PROJECT INFORMATION	1
1.1 General	1
1.2 Description of Project	1
1.3 Pertinent Data	2
SECTION 2 - ENGINEERING DATA	5
2.1 Design	5
2.2 Construction	6
2.3 Operation	6
2.4 Other Investigations	6
2.5 Evaluation	6
SECTION 3 - VISUAL INSPECTION	9
3.1 Findings	9
3.2 Evaluation	10
SECTION 4 - OPERATIONAL FEATURES	11
4.1 Procedures	11
4.2 Maintenance of the Dam	11
4.3 Maintenance of Operating Facilities	11
4.4 Warning System in Effect	11
4.5 Evaluation	11
SECTION 5 - HYDRAULICS AND HYDROLOGY	12
5.1 Evaluation of Features	12
SECTION 6 - STRUCTURAL STABILITY	13
6.1 Evaluation of Structural Stability	13
SECTION 7 - ASSESSMENT AND RECOMMENDATIONS/REMEDIAL MEASURES	14
7.1 Dam Assessment	14
7.2 Recommendations/Remedial Measures	14

ACCESSION NO.	
NTIS	Write Section <input checked="" type="checkbox"/>
DOC	Ref Section <input type="checkbox"/>
UNANNOUNCED	<input type="checkbox"/>
JUSTIFICATION	
BY	
DISTRIBUTION/AVAILABILITY CODES	
Dist.	AVAIL. add. or SPECIAL
A	

TABLE OF CONTENTS
(Continued)

PLATES

APPENDIX A - CHECKLIST, VISUAL INSPECTION, PHASE I

APPENDIX B - CHECKLIST, ENGINEERING DATA, DESIGN, CONSTRUCTION,
OPERATION, PHASE I

APPENDIX C - PHOTOGRAPHS

APPENDIX D - CALCULATIONS

APPENDIX E - REGIONAL GEOLOGY

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM
BRUSH MOUNTAIN DAM
NDI I.D. NO. 539
DER I.D. NO. 7-5

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority. The inspection was performed pursuant to the authority granted by The National Dam Inspection Act, Public Law 92-367, to the Secretary of the Army, through the Corps of Engineers, to conduct inspections of dams throughout the United States.

b. Purpose. The purpose of this inspection is to determine if the dam constitutes hazard to human life or property.

1.2 Description of Project

a. Dam and Appurtenances. The dam consists of an earth embankment 800 feet long, with a maximum height of 54 feet from the downstream toe. The combined primary and emergency spillway is located on the left abutment (looking downstream). The flow through the chute spillway is controlled by a broad-crested weir almost 54 feet wide at an elevation approximately 5-1/2 feet below the dam crest. The spillway chute is a 6-foot-deep rectangular channel with masonry walls and concrete bottom which discharges directly into the stream near the left abutment. The outlet works consist of two 16-inch cast-iron pipes located in a horseshoe-shaped tunnel through the embankment midway between the abutments. Available drawings indicate that this tunnel is blocked by a brick bulkhead at the upstream end. Discharge through these pipes is apparently controlled by valves located at an intake tower within the reservoir. The intake tower is accessible by boat only. Available information indicates that the two 16-inch pipes are the only emergency drawdown facility for the impoundment.

b. Location. Brush Mountain Dam is located near the headwaters of Kettle Creek, four miles east of Altoona, in Tyrone Township, Blair County, Pennsylvania (Plate 1).

Below the reservoir, Kettle Creek flows northwest through a steep and narrow valley over a distance of about one mile, where it turns north, flows through a small distribution reservoir with a surface area of about two acres, then continues north and discharges

into Pottsgrove Reservoir about two miles downstream from Brush Mountain Dam near the east end of Altoona. Downstream from Pottsgrove Reservoir, Kettle Creek flows northwest about one and one-half miles through residential areas of Altoona and joins the Little Juniata River. In this reach, the stream flows under U.S. Route 220 and State Route 764. The stream, in the last several hundred feet of its course, is confined to a storm sewer and discharges into Little Juniata River through a five-foot corrugated metal pipe.

It is estimated that failure of Brush Mountain Dam would also result in failure of Pottsgrove Reservoir and the combined discharge would cause large loss of life and property damage in the east end of Altoona.

c. Size Classification. Intermediate (based on 54-foot height).

d. Hazard Classification. High.

e. Ownership. Blair Gap Water Supply Company. (Mr. James Dotson, Manager, Box 20, Greenwood Road, Altoona, PA 16602.)

f. Purpose of Dam. Water supply.

g. Design and Construction History. According to a state inspection report entitled, Report Upon the Brush Mountain Dam, dated October 8, 1914, the dam was built in 1888 by the Campbell brothers, based on a design prepared by Pennsylvania Railroad Company engineers. The dam was repaired in 1912 by the American Pipe and Manufacturing Company. The spillway of the dam received additional repairs in 1928 and 1936.

h. Normal Operating Procedure. The reservoir is normally maintained at the uncontrolled spillway crest level, Elevation 1712, leaving five feet of freeboard to the top of the dam, as measured in the field during this inspection. All inflow occurring when the reservoir is at or above the spillway crest level is discharged through the spillway.

1.3 Pertinent Data

a. Drainage Area (square miles) - 2.5

b. Discharge at Dam Site (cfs)

Maximum known flood at dam site - 450 in the 1936 flood
Warm water outlet at pool elevation - N/A
Diversion tunnel low pool outlet at pool elevation - N/A
Diversion tunnel outlet at pool elevation - N/A
Gated spillway capacity at pool elevation - N/A
Gated spillway capacity at maximum pool elevation - N/A

Ungated spillway capacity at maximum pool elevation -
1570 at Elevation 1723

Total spillway capacity at maximum pool elevation -
1570 at Elevation 1723

c. Elevation (USGS Datum) (feet)

Top of dam - 1724 (as designed); 1723 (as measured)

Maximum pool-design surcharge - Unknown

Full flood control pool - N/A

Recreation pool (normal pool) - 1718

Spillway crest - 1718

Upstream portal invert diversion tunnel - N/A

Downstream portal invert diversion tunnel - N/A

Streambed at center line of dam - 1670⁺

Maximum tailwater - 1670⁺ (estimated)

d. Reservoir (feet)

Length of maximum pool - 2400

Length of recreation pool - N/A

Length of flood control pool - N/A

e. Storage (acre-feet)

Recreation pool (normal pool) - 577

Flood control pool - N/A

Design surcharge (minimum) - 857 at Elevation 1723

Top of dam - 857 at Elevation 1723

f. Reservoir Surface (acres)

Top of dam - 36⁺

Maximum pool - N/A

Flood control pool (normal pool) - 31 at Elevation 1718

Recreation pool - N/A

Spillway crest - 31

g. Dam

Type - Earth

Length - 800 feet

Height - 54 feet

Top width - 20 feet

Side slopes - 2H:1V (upstream); 1.5H:1V (downstream)

Zoning - No

Impervious core - Yes (upstream toe)

Cutoff - Yes

Grout curtain - Remedial grouting 1912, extent unknown

h. Diversion and Regulating Tunnel

Type - Two 16-inch-diameter cast iron pipes

Length - Unknown

Closure - Valves in intake tower

Access - Intake tower is accessible by boat only

Regulating facilities - Valves

i. Spillway

Type - Broad-crested weir

Length of weir - 54 feet (as measured)

Crest elevation - 1718 feet

Gates - None

Upstream channel - Lake

Downstream channel - Rectangular masonry channel

SECTION 2
ENGINEERING DATA

2.1 Design

a. Data Available

(1) Hydrology and Hydraulics. Design information consists of design drawings for 1928 and 1936 repairs to the spillway channel. No other information is available.

(2) Embankment. The available information includes a limited number of design drawings and various past state inspection reports.

(3) Appurtenant Structures. No design information is available.

b. Design Features

(1) Embankment. A review of the design drawings and the correspondence files for the dam show the following main features of the project:

(a) The 1914 report states that there was no indication that any subsurface investigation was conducted prior to the construction of the dam in 1888. This report further states that the original embankment consisted of two zones: compacted select material in the upstream half, and "rough material" (stones, etc.) in the downstream half. The downstream slope was built on a 1-1/4 horizontal to one vertical slope. The original design did not include an impervious core or cutoff wall.

(b) In 1912, the dam was repaired to stop seepage that had existed at the toe area since the completion of the dam. The repair work consisted of constructing a concrete cutoff wall along the upstream toe of the embankment, extending through the bottom of the spillway channel, construction of a concrete slab on the upstream face of the dam, and reducing the downstream slope of the dam to 1.5H:1V by additional fill. The crest and downstream face of the dam was lined with riprap (Plate 2).

(c) A letter addressed to the state by the owner, dated August 23, 1919, reports that the 1912 repairs also included foundation grouting.

The left abutment was grouted through 64 holes, using 166 bags of cement. In the right abutment, 31 holes were drilled and 139 bags of cement used for grouting.

- (d) As stated in the 1914 report, the geological formations at the site consist of stratified sandstone and shales dipping at an angle of 15 to 20 degrees in an upstream direction.

(2) Appurtenant Structures. The appurtenant structures for the dam consist of an uncontrolled spillway and outlet works. The spillway structures consist of a broad-crested weir spillway and a rectangular concrete discharge channel which discharges directly into Kettle Creek (Plates 3 and 4). The two 16-inch cast-iron pipes located in the diversion channel through the embankment constitute the outlet works of the reservoir. Description of the appurtenant structures is included in Section 1.2.

c. Design Data

- (1) Hydrology and Hydraulics. No design data are available.

(2) Embankment. No data are available on the design of the embankment.

(3) Appurtenant Structures. There are no design data available for the appurtenant structures.

2.2 Construction. No information on the construction of the dam is available other than as reported in the 1914 report, which was previously summarized.

2.3 Operation. There are no formal operating procedures for the dam. The spillway of the impoundment is uncontrolled and has no operational features.

The blow-off pipes for the dam are apparently controlled by valves at the intake tower. The tower is accessible by boat only.

2.4 Other Investigations. The available information includes various periodic inspection reports conducted by the state since 1914.

2.5 Evaluation

a. Availability. Available engineering data were provided by PennDER.

b. Adequacy

(1) Hydrology and Hydraulics. No hydrology and hydraulic data are available.

(2) Embankment. In view of the age of the dam, built in 1888 and repaired in 1912, the design approach and construction techniques are not likely to be in conformance with currently accepted engineering practice. Other than a typical cross section of the embankment as repaired in 1912, no quantitative data are available to assess the embankment.

However, the 1912 repairs incorporated such basic components as a cutoff trench extending to impervious material, foundation grouting, and riprap protection of the downstream slope and the crest.

(3) Appurtenant Structures. Review of the design drawings indicates there are no significant design deficiencies that should affect the overall performance of the spillway structures. However, no information is available on the diversion tunnel through the embankment, intake tower, and drainpipes to assess their design.

c. Operating Records. There are no formal operating records available for the dam. A state inspection report dated May 14, 1936 states that during the flood of March 1936, the maximum depth of flow over the 54-foot-wide spillway was 2.1 feet. This flow depth corresponds to a discharge rate of about 450 cfs.

d. Post-Construction Changes. As previously discussed, the dam received major repairs in 1912. The 1914 inspection report states that the primary purpose of the repairs was to stop seepages which had existed in the toe area since the construction of the dam. It is further stated that in spite of the fact that the 1912 repairs included construction of a cutoff wall on the upstream slope of the dam extending down to impervious material, the amount of seepage was not reduced. The reported total seepage in the toe area in 1912 was 0.1 cfs.

A letter by the Blair Gap Water Supply Company dated May 9, 1946, indicates that as of 1946 the seepage at the toe area of the dam was being monitored by three seepage weirs (Plate 5), and the following comparative data were given:

WEIR	SEEPAGE IN GALLONS PER DAY			
	1928	HIGH	LOW	1946
A	120,000	135,000	51,000	56,000
B	80,000	94,000	75,000	92,000
C	120,000	174,000	56,000	162,000

Other post-construction changes include the construction of the spillway channel in 1928 and repairs to the spillway channel in 1936.

e. Seismic Stability. The dam is located in Seismic Zone 1 and static stability of the dam is considered to be adequate. Therefore, based on the recommended criteria for evaluation of seismic stability of dams, the structure is assumed to present no hazard from earthquakes.

SECTION 3 VISUAL INSPECTION

3.1 Findings

a. General. The on-site inspection of Brush Mountain Dam consisted of:

1. Visual inspection of the embankment, abutments, and embankment toe.
2. Visual examination of the spillway and its components, the downstream end of the outlet pipe, and other appurtenant features.
3. Observation of factors affecting the runoff potential of the drainage basin.
4. Evaluation of the downstream area hazard potential.

The specific observations are illustrated in Plate 6 and in the photographs in Appendix C.

b. Embankment. The general inspection of the embankment consisted of searching for indications of structural distress, such as cracks, subsidence, bulging, wet areas, seeps and boils, and observing general maintenance conditions, erosion, and other surficial features.

1. All seepage areas observed at the toe of the dam (Plate 6) coincided with the seepage areas that previously existed as implied by the locations of the monitoring weirs (Plate 5). Total seepage flow from the right abutment area was estimated to be 90 gallons per minute (gpm). The seepage on the left side of the outlet works discharge channel was estimated to be 50 gpm. Total flow in the outlet works discharge channel was estimated to be 100 gpm.
2. Minor seepage was observed in the spillway discharge channel and the seepage quantity was estimated to be 5 gpm.

3. Surficial slides in the downstream riprap were observed. These slides appeared to be causing bulges in the riprap near the toe of the dam.

c. Appurtenant Structures. The intake tower and diversion tunnel through the embankment were inaccessible and therefore were not inspected.

The spillway structures were examined for deterioration or other signs of distress and obstructions that would limit flow. It was observed that most of the grouted riprap channel floor pavement that was constructed in 1936 in the spillway channel below Elevation 1693 has been eroded away; however, this has not affected the overall performance of the channel. The remaining parts of the spillway are considered to be in good condition.

The downstream end of the outlet pipe was examined and was found to be in fair condition.

d. Reservoir Area. The watershed is predominantly covered with woodlands and infiltration capacity is estimated to be good.

A review of the regional geology (Appendix E) indicates that the shorelines are not likely to be susceptible to massive landslides which would affect the storage volume of the reservoir or cause overtopping of the dam by displaced water.

e. Downstream Channel. Kettle Creek, downstream from the dam, flows through a narrow and steep valley before discharging into Pottsgrove Reservoir near the east end of Altoona. Below Pottsgrove Dam, Kettle Creek flows through residential areas north of Altoona. The photographs in Appendix C illustrate the downstream channel conditions of Kettle Creek. A description of the downstream channel was also included in Section 1.2.

3.2 Evaluation. While the general condition of the embankment appears to be fair, requiring riprap repairs to avoid future erosion problems, the condition of the outlet works could not be assessed because the intake tower was inaccessible. The condition of the spillway is also considered to be fair, requiring repairs to the damaged channel floor.

Although the comparison of the estimated seepage quantities with the past records indicates that the amount of seepage is not increasing, seepage quantities should still be monitored to aid in future assessment of the conditions. Presently, all three seepage weirs are nonfunctional.

SECTION 4 OPERATIONAL FEATURES

4.1 Procedures. Review of the design drawings and field observations indicate that there are no formal procedures for operating the dam. The operational feature of the dam which may affect the safety of the dam is the outlet pipe valve, in case it is required to lower the reservoir.

The clearing of debris from the spillway as required and the continued inspection of the facilities by the dam tender are the principal maintenance operations which would affect safety.

4.2 Maintenance of the Dam. The maintenance condition of the embankment is considered to be fair. Riprap slides require repairs to avoid future erosion problems.

4.3 Maintenance of Operating Facilities. The water company declined to operate the blow-off valve for the dam without compensation for this service and for any damages due to operation. Therefore, the operative condition of the drawdown facilities could not be assessed. The intake tower was inaccessible and was not inspected. Visual observations from the crest of the dam indicate the operation equipment at the intake tower is in poor condition.

4.4 Warning System in Effect. No formal flood warning system exists for Brush Mountain Dam. The dam is maintained by water company personnel operating from the company office in Altoona, approximately four miles downstream of the dam.

4.5 Evaluation. The operational condition of the dam is considered to be poor. The operative condition of the drawdown facilities was not observed. The dam is accessible under all weather conditions for inspection and emergency action.

SECTION 5
HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features

a. Design Data. Brush Mountain Dam has a watershed area of 2.5 square miles and impounds a reservoir with a surface area of 31 acres. A 54-foot-wide by 6-foot-deep chute spillway constitutes both the primary and emergency spillway for the impoundment. As it exists, the spillway is controlled by a broad-crested weir and has a maximum discharge capacity of 1570 cfs with no freeboard.

b. Experience Data. Brush Mountain Dam is classified to be an "intermediate" size dam in the "high" hazard category. Under the recommended criteria for evaluating emergency spillway discharge capacity, such impoundments are required to pass the probable maximum flood (PMF).

The adequacy of the spillway was analyzed based on the simplified procedure developed by the Baltimore District, Corps of Engineers. Based on this procedure, it was determined that the PMF inflow hydrograph will have a peak flow of 8600 cfs and a total volume of approximately 3500 acre-feet. Both of these values are greater than the spillway capacity of 1570 cfs and the flood storage volume of 180 acre-feet. Therefore, the spillway is not capable of passing the PMF flow without overtopping. Further analysis, according to the procedure, indicated that the spillway can pass a maximum flow of approximately 23 percent of the PMF without overtopping of the dam. In the event of full PMF, it is calculated that the dam would be overtopped by about 2 feet.

c. Visual Observations. On the date of inspection, no conditions were observed that would indicate that the spillway of the dam could not operate satisfactorily in the event of a flood.

d. Overtopping Potential. As stated above, the dam will be overtopped during a flood whose magnitude exceeds 23 percent PMF.

e. Spillway Adequacy. As previously stated, the capacity of the spillway is less than 50 percent PMF. It is estimated that overtopping would result in failure of the dam, significantly increasing the damage potential from that which would exist just before overtopping failure.

Based on these considerations, the spillway is classified to be "seriously inadequate" according to the recommended criteria.

It is estimated that overtopping of the embankment would result in failure of the dam.

SECTION 6 STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. As discussed in Section 3, the field observations did not reveal any signs of distress that would significantly affect the stability of the dam and none were reported in the past. The intake tower and diversion tunnel were not inspected.

b. Design and Construction Data

(1) Embankment. The dam was designed at a time (1888) when limited understanding of the geotechnical behavior of earth structures existed. Consequently, the available information includes no quantitative data to aid in the assessment of embankment stability.

Available information indicates that the dam received major repairs in 1912 to stop seepage which had existed in the toe area since the construction of the dam. It is reported that the 1912 repairs did not significantly decrease the amount of seepage. Other reports of seepage measurements indicate that during the period between 1928 and 1946 seepage quantities were relatively stable and ranged between 120 to 280 gallons per minute. In this inspection, total seepage flow is estimated to be about 190 gallons per minute.

(2) Appurtenant Structures. No design information is available for the diversion tunnel and intake tower to assess the structural adequacy of these appurtenances.

c. Operating Records. The structural stability of the dam is not considered to be affected by the operational features of the dam.

d. Post-Construction Changes. There have been no reported modifications to the dam after the 1912 repairs that would affect the structural stability of the embankment.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS/REMEDIAL MEASURES

7.1 Dam Assessment

a. Assessment. The visual observations and review of available information indicate that Brush Mountain Dam is in fair condition. It appears that the dam was constructed with reasonable care. Field observations did not reveal any significant signs of distress and none were reported in the past.

The spillway was considered to be "seriously inadequate" because its capacity (23 percent PMF) is less than 50 percent PMF and because it is estimated that overtopping of the embankment would result in failure, significantly increasing the hazard potential which existed just prior to overtopping.

b. Adequacy of Information. The available information in conjunction with visual observations and previous experience of the inspectors are considered to be sufficient to make a reasonable assessment of the dam.

c. Urgency. More detailed evaluation of the spillway should be made immediately and other recommendations below should be implemented as soon as practicable or on a continuing basis.

d. Necessity for Further Investigation. The adequacy of the spillway is considered to require immediate further investigation. The embankment is considered to require no further investigation.

7.2 Recommendations/Remedial Measures

1. The owner should initiate additional hydrology and hydraulic studies to more accurately ascertain the spillway capacity and to determine the nature and extent of remedial measures required to increase the spillway capacity.
2. It is recommended that the owner immediately evaluate the operational condition of the outlet works and perform necessary maintenance.
3. Since the intake tower and diversion tunnel were inaccessible, the condition of these structures could not be assessed. Therefore, the owner should evaluate the structural integrity of these structures on a periodic basis.

4. It is recommended that the owner repair the seepage weirs at the toe of the dam and monitor and record seepage quantities regularly.
5. It is recommended that the owner repair the riprap slides on the downstream slope of the dam to avoid future erosion problems.
6. Because the dam may overtop during unusually high runoff, it is recommended that during such periods the owner should provide around-the-clock surveillance for early detection of problems, such as erosion. It is also recommended that the owner should develop a formal warning system to alert the downstream residents in the event of emergencies.
7. It is recommended that the owner be advised that the dam and appurtenant structures should be inspected regularly and properly maintained.

PLATES

DRAWN BY D.J.D. CHECKED BY JAE 7-26-78 DRAWING NUMBER 76-14-116
 APPROVED BY JAP 7-26-78



REFERENCE:

U.S.G.S., 75', ALTOONA, BELLWOOD,
 FRANKSTOWN AND HOLLIDAYSBURG PA.
 QUADRANGLE DATED: 1963
 PHOTOREVISED 1972, SCALE - 1:2000.

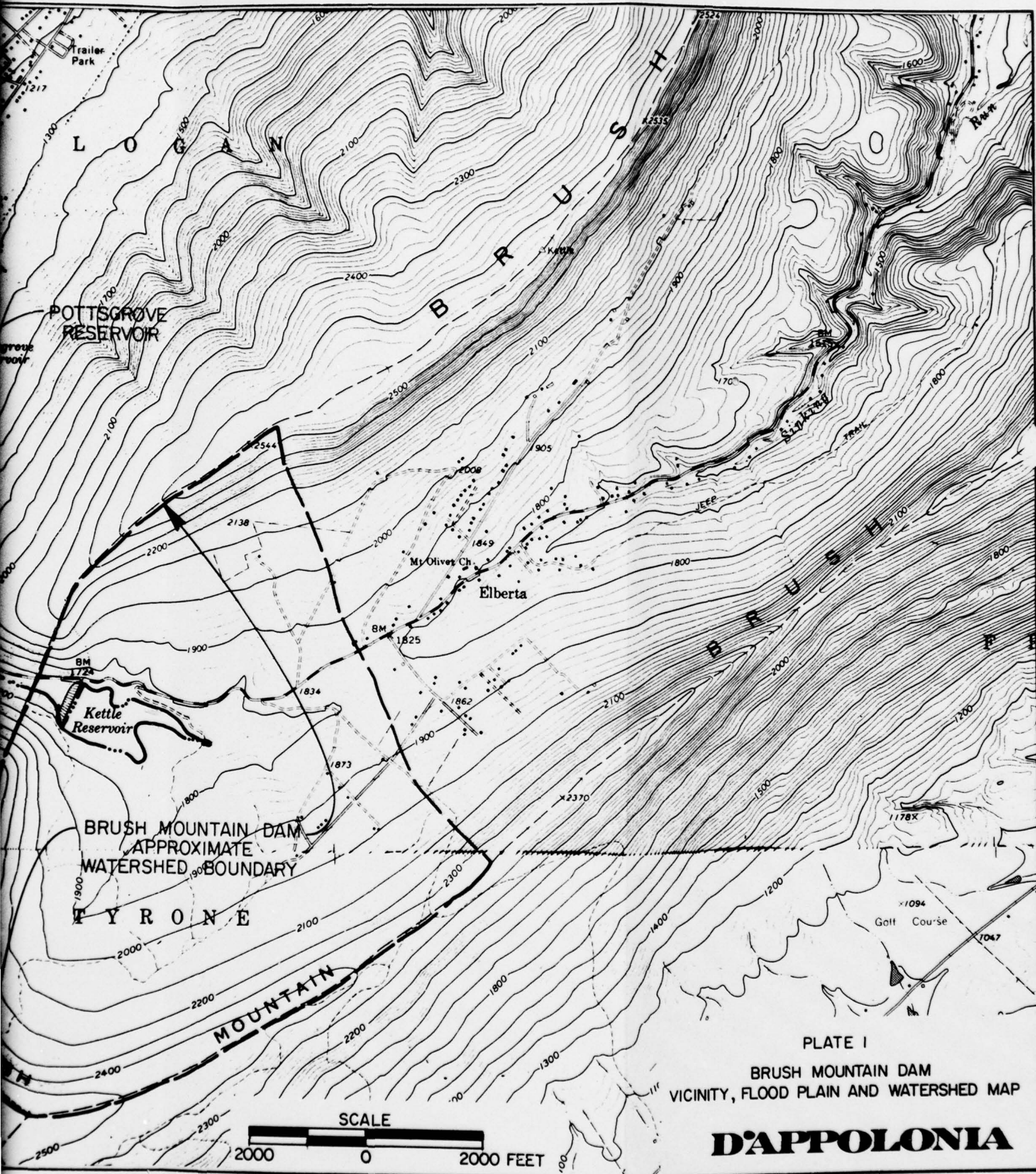


PLATE I

BRUSH MOUNTAIN DAM
VICINITY, FLOOD PLAIN AND WATERSHED MAP

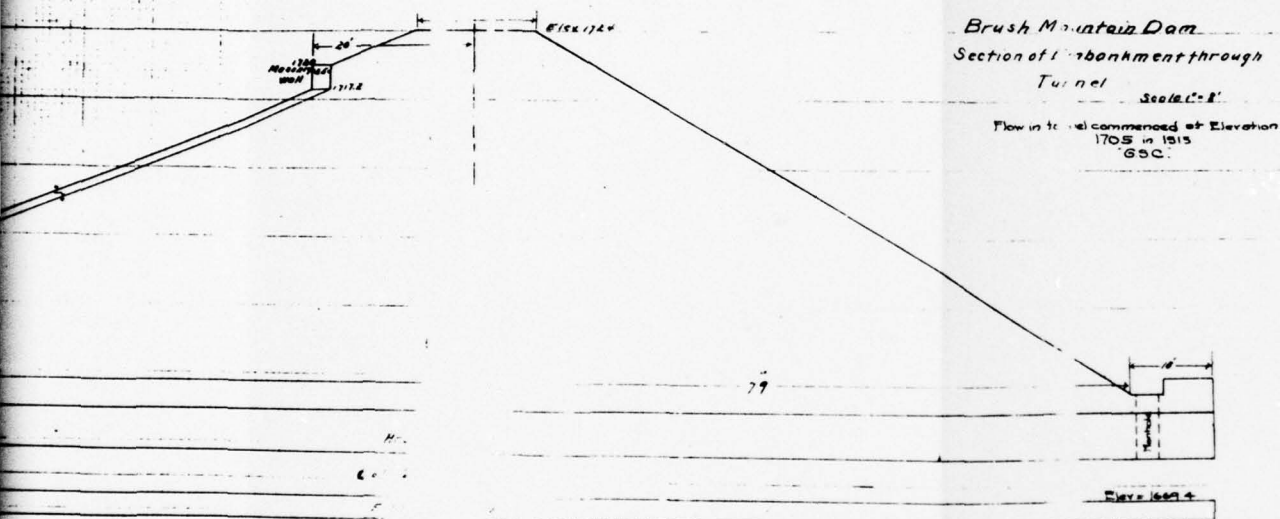
D'APPOLONIA

DRAWN BY

**DRAWN
BY**



THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDC



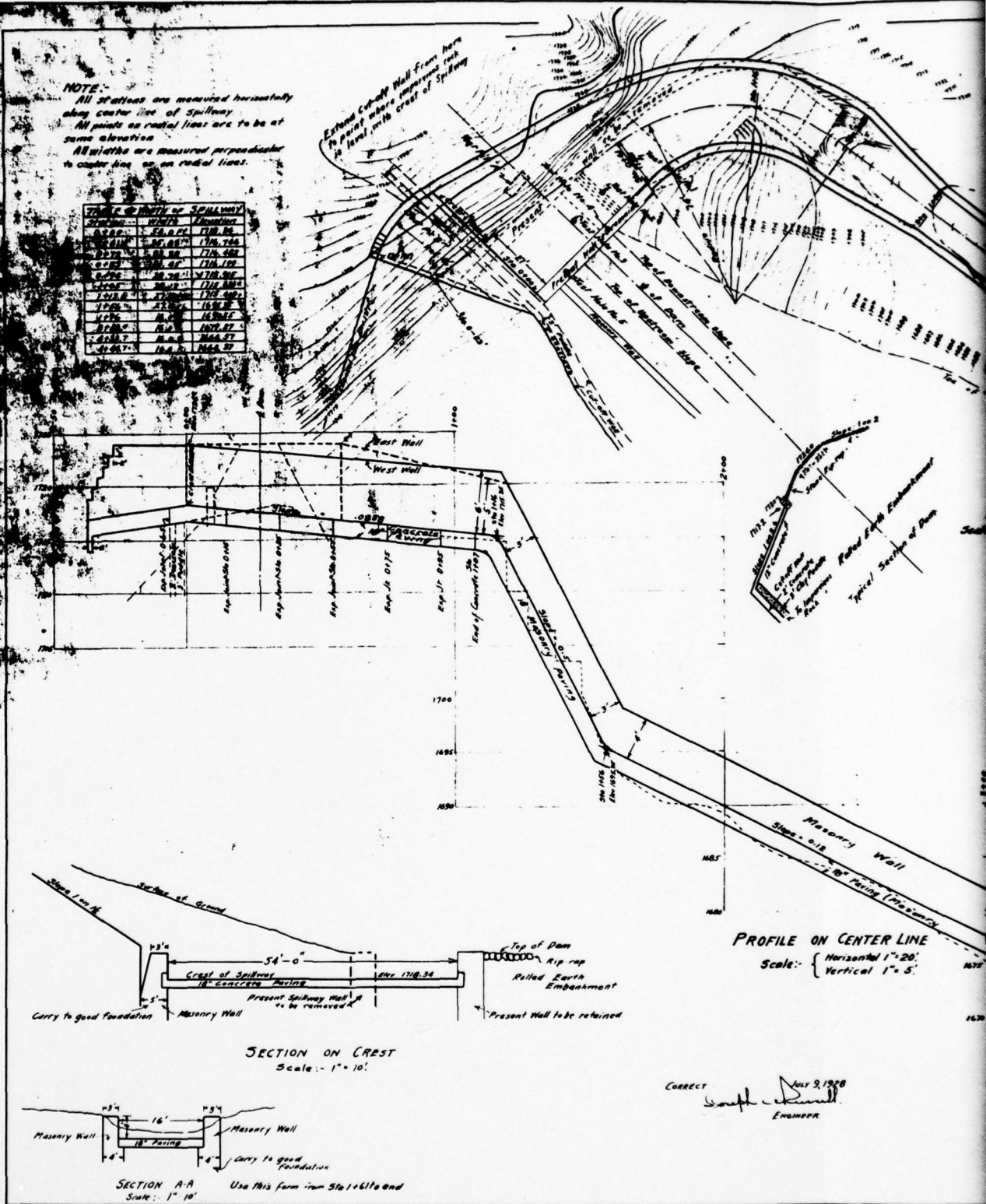
THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDG

PLATE 2

D'APPOLONIA

NOTE:
 All stations are measured horizontally along center line of Spillway.
 All points on radial lines are to be at same elevation.
 All widths are measured perpendicular to center line on a radial line.

Station	Width	Elevation
1710.00	18.00	1710.00
1710.25	18.00	1710.25
1710.50	18.00	1710.50
1710.75	18.00	1710.75
1711.00	18.00	1711.00
1711.25	18.00	1711.25
1711.50	18.00	1711.50
1711.75	18.00	1711.75
1712.00	18.00	1712.00
1712.25	18.00	1712.25
1712.50	18.00	1712.50
1712.75	18.00	1712.75
1713.00	18.00	1713.00
1713.25	18.00	1713.25
1713.50	18.00	1713.50
1713.75	18.00	1713.75
1714.00	18.00	1714.00



THIS PAGE IS BEST QUALITY PRACTICABLE
 FROM COPY FURNISHED TO DDC

LOCATION:-

NETTLE CREEK - 3 MILES EAST OF ALTOONA, PA
TOWNSHIP OF TYONE - COUNTY OF BLAIR
RESERVOIR CAPACITY AT FLOW LINE 187,810,000 GALS
DRAINAGE AREA 2.46 SQUARE MILES

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDC

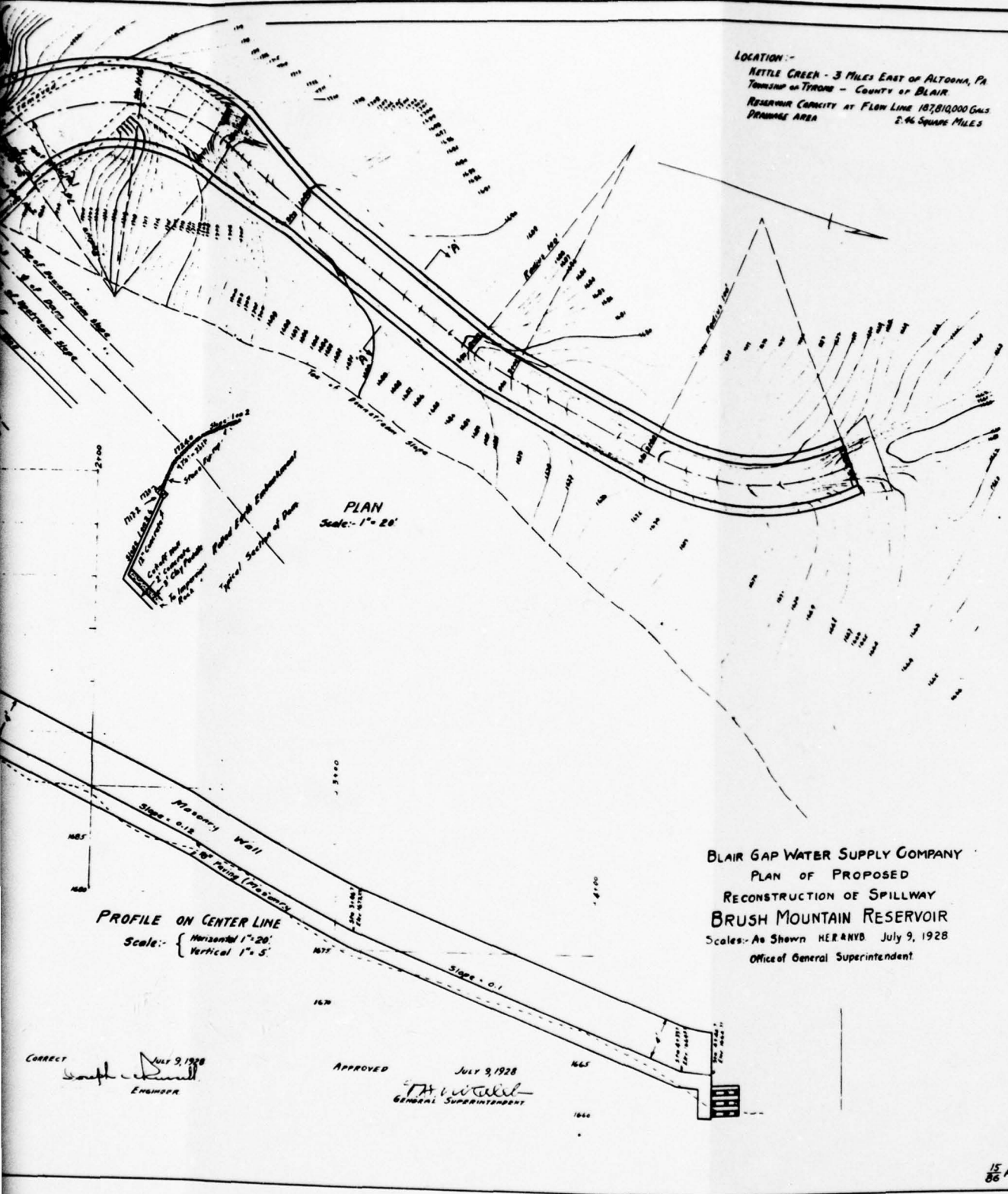
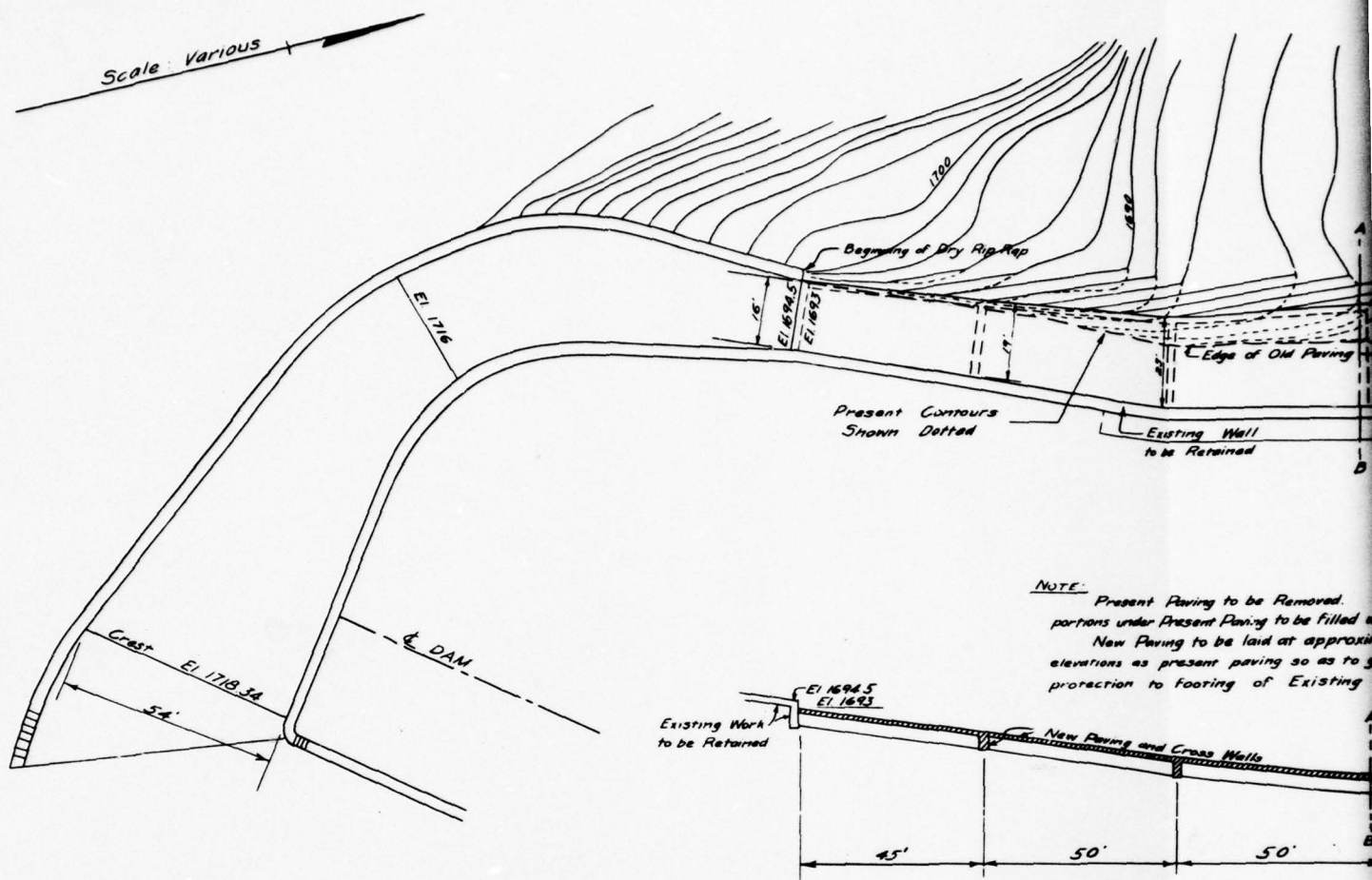


PLATE 3

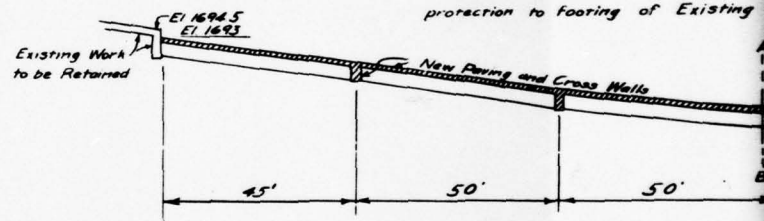
D'APPOLONIA

DRAWN BY D.J.D. 7-20-78 CHECKED BY BE 7-26-78 DRAWING NUMBER 78-114-B96
 APPROVED BY J.H.P. 7-26-78

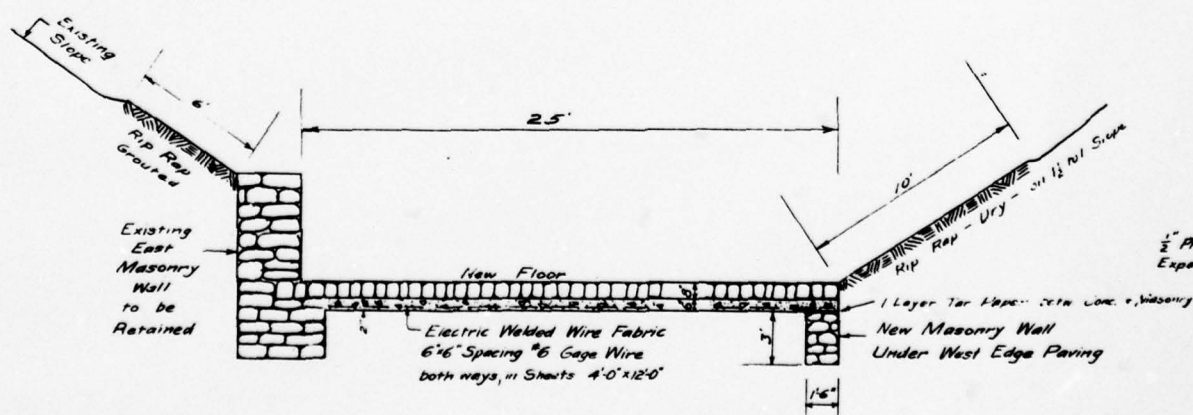
Scale Various



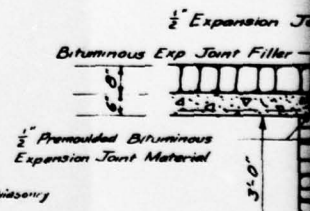
NOTE: Present Paving to be Removed, portions under Present Paving to be Filled in. New Paving to be laid at approximate elevations as present paving so as to give protection to footing of Existing



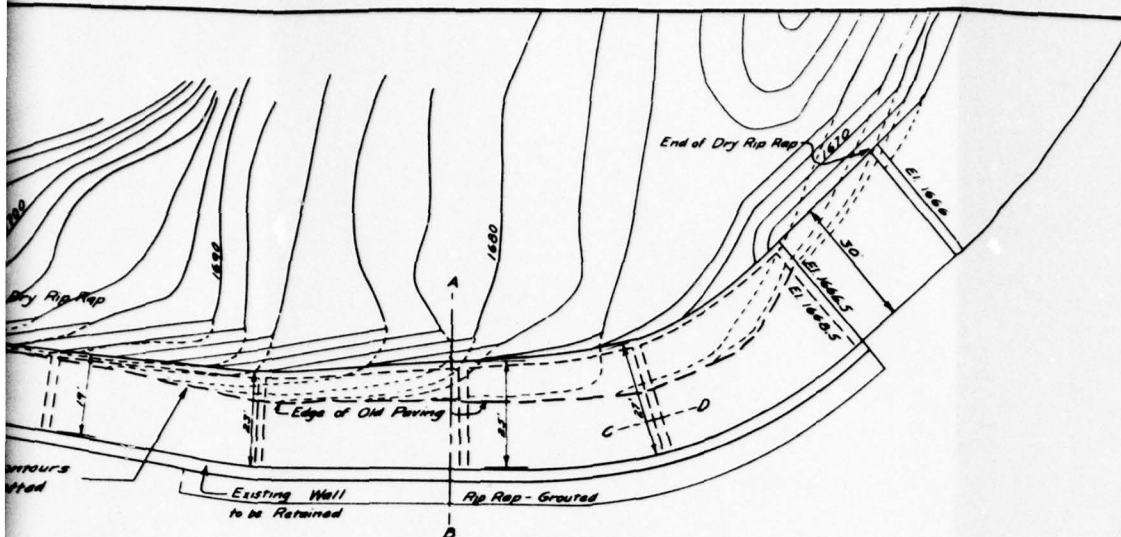
PROFILE ON NEW SCALE: 1" = 20'



SECTION A-B
 SCALE: 1" = 4'

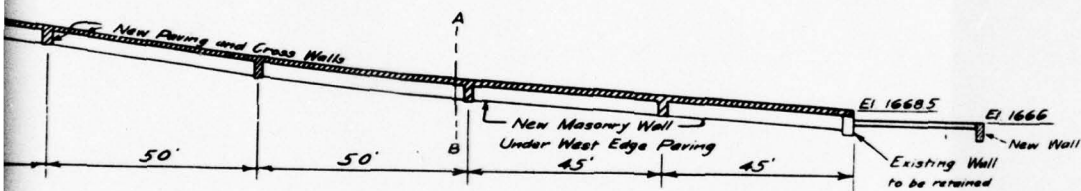


SECTION SCALE

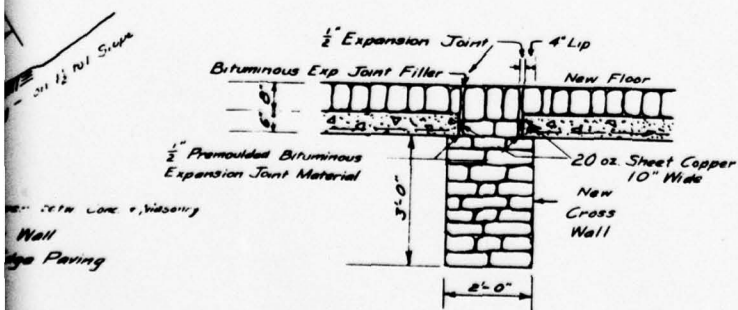


PLAN OF WASTEWAY
SCALE: 1" = 20'

NOTE: Present Paving to be Removed. Washed out portions under Present Paving to be Filled with Stone.
New Paving to be laid at approximately same elevations as present paving so as to give proper protection to footing of Existing Wall.



PROFILE ON NEW & WASTEWAY
SCALE: 1" = 20'



SECTION C-D
SCALE: 1" = 8'

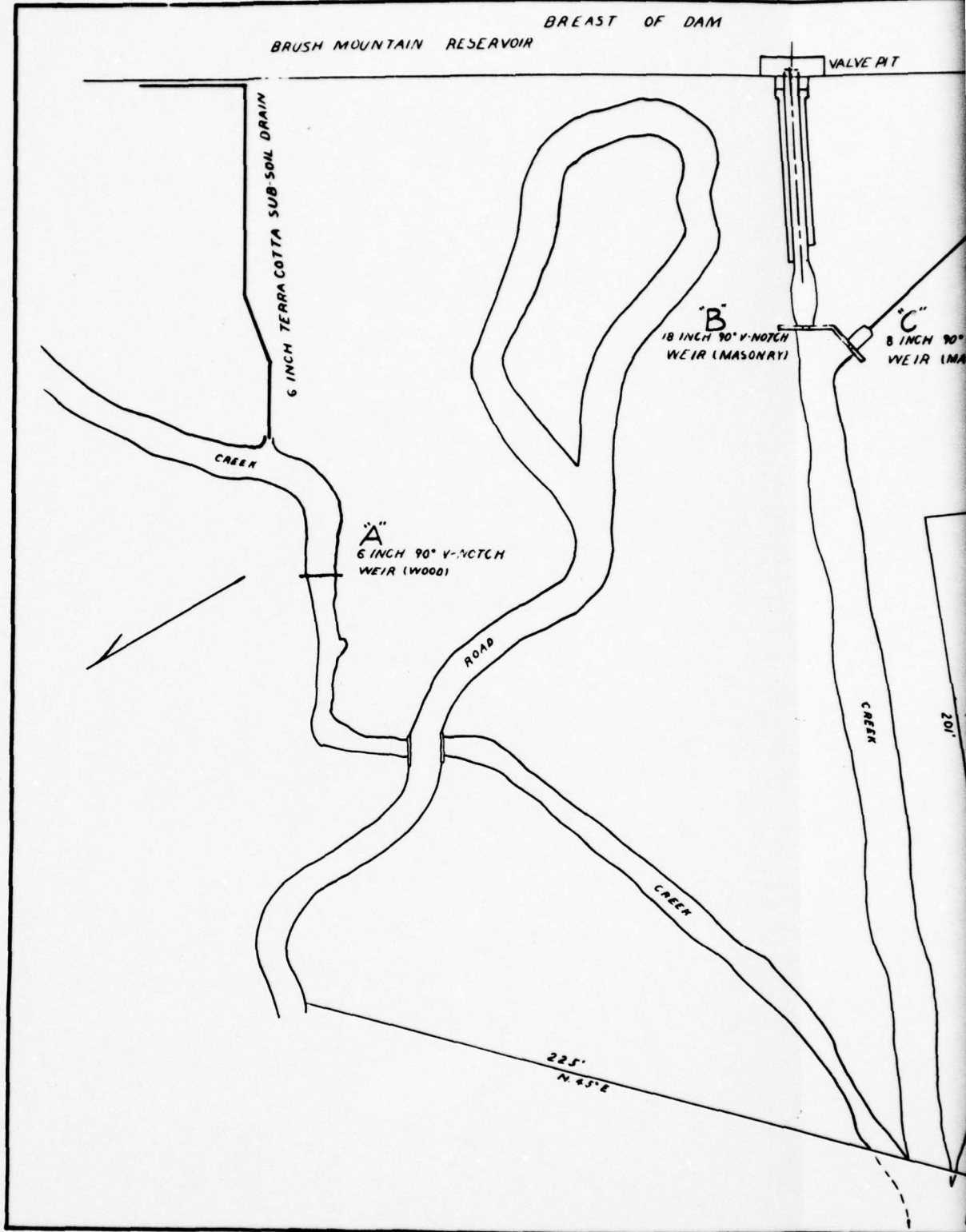
BLAIR GAP WATER SUPPLY CO.
BRUSH MT. DAM
PROPOSED WASTEWAY CHANNEL

SCALE AS INDICATED JF 6-12-36

PLATE 4

D'APPOLONIA

DRAWN BY	D.J.D. 7-20-78	CHECKED BY JHP	7-26-78	DRAWING NUMBER	78-14-B97
					7-26-78



ST OF DAM

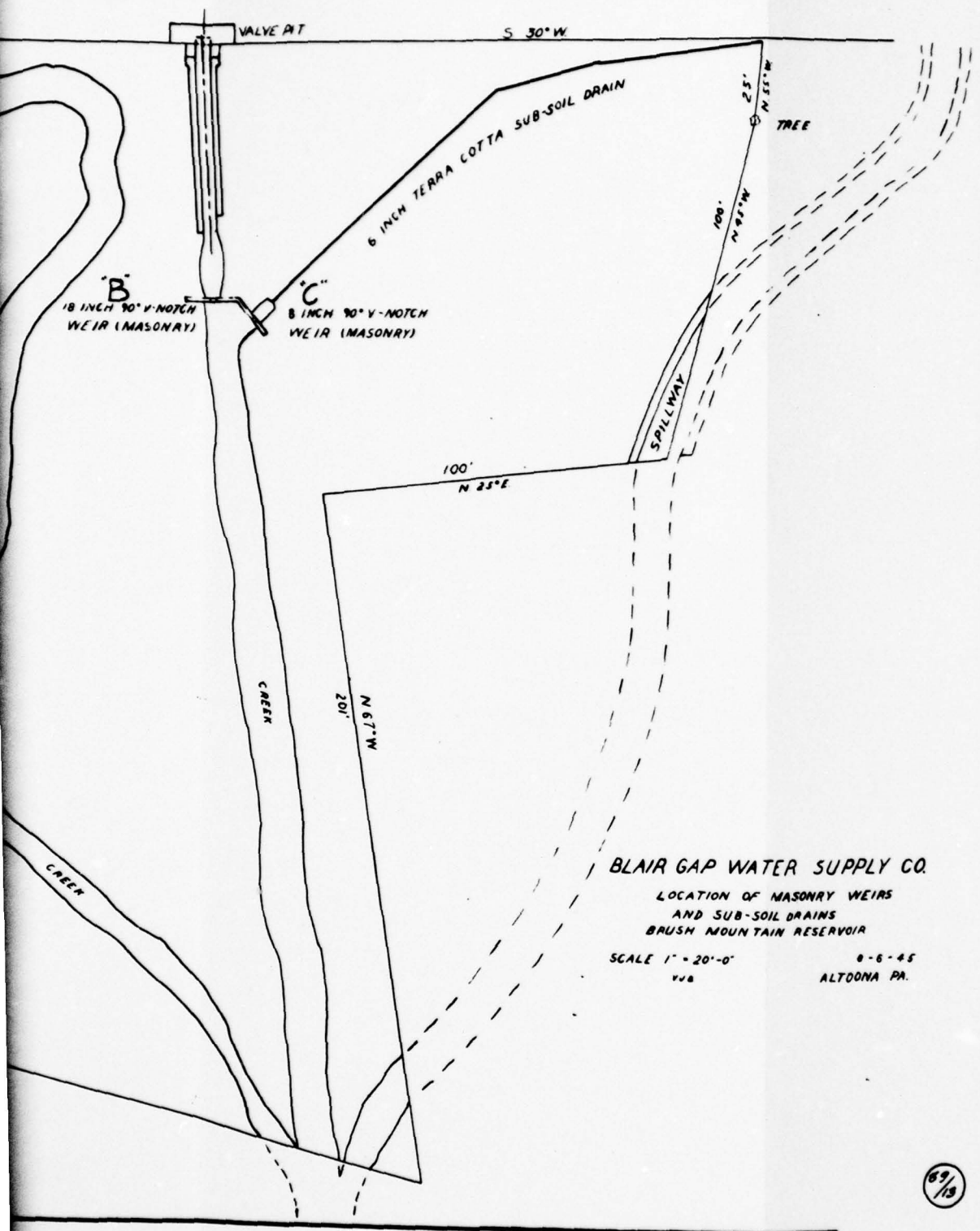


PLATE 5

D'APPOLONIA

2

DRAWN BY	D.J.D.	CHECKED BY	SK	7-26-78	DRAWING NUMBER	78	1-A17
	7-18-78	APPROVED BY	JHD	7-26-78			

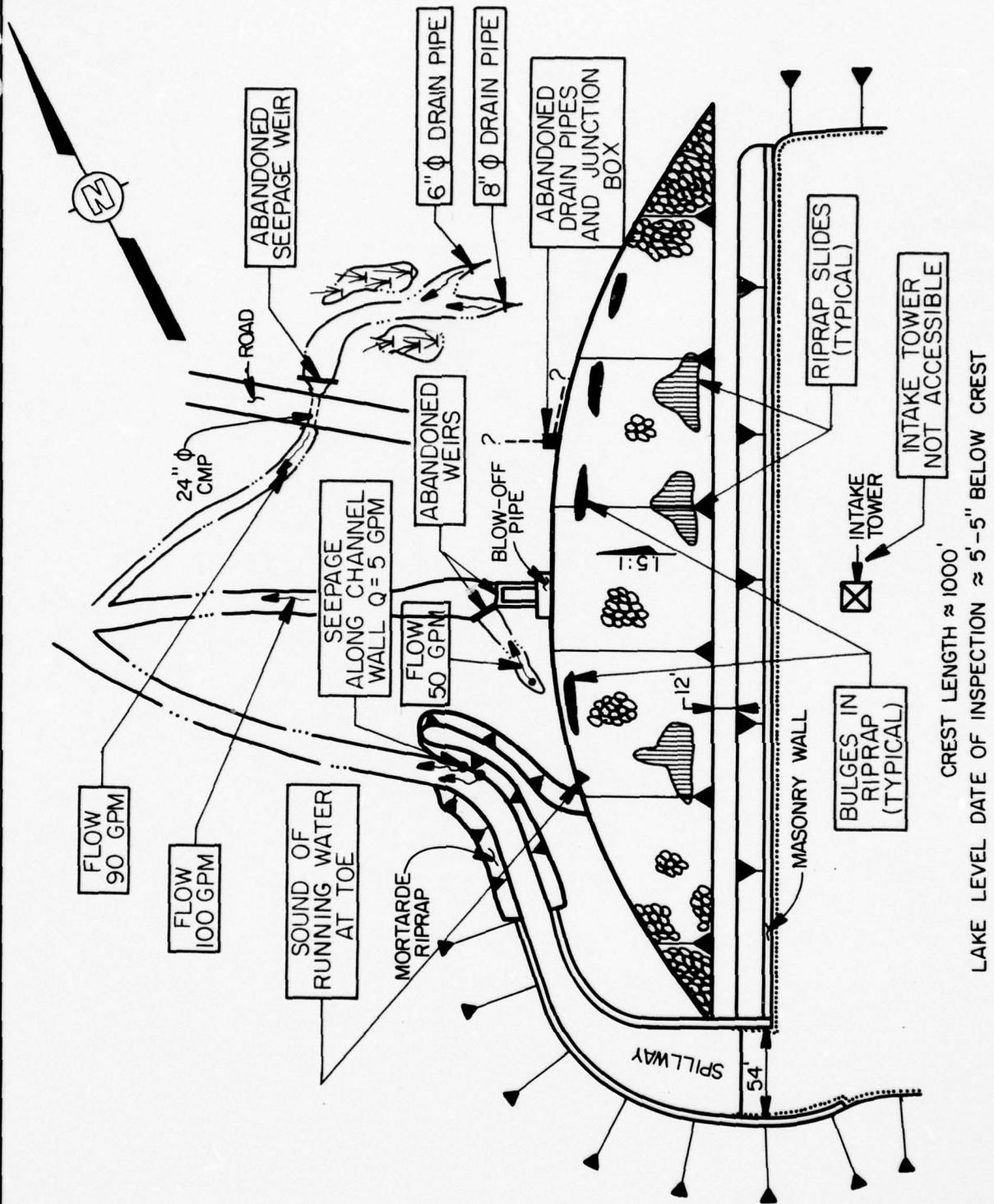


PLATE 6

BRUSH MOUNTAIN DAM
 GENERAL PLAN
 FIELD INSPECTION NOTES
 FIELD INSPECTION DATE : JULY 10 , 1978

D'APPOLONIA

APPENDIX A
CHECKLIST
VISUAL INSPECTION
PHASE I

CHECKLIST
VISUAL INSPECTION
PHASE I

NAME OF DAM Baugh Mountain Dam COUNTY BLAIR CO. STATE PA. ID# NDI: 539 DER: 7-5

TYPE OF DAM EARTH FILL HAZARD CATEGORY HIGH.

DATE(S) INSPECTION JULY 10, 1978 WEATHER SUNNY TEMPERATURE 80.5

POOL ELEVATION AT TIME OF INSPECTION 1718 M.S.L. TAILWATER AT TIME OF INSPECTION 1664 ± M.S.L.

INSPECTION PERSONNEL:

<u>BILGIN EREL</u>	<u>REVIEW INSPECTION BY:</u>	<u>ELIO D'ADDOLONIA</u>
<u>WAH-TAE CHAN</u>	<u>(JULY 18, 1978)</u>	<u>LARRY ANDERSEN</u>
		<u>JAMES DOELLOT</u>

BILGIN EREL RECORDER

VISUAL INSPECTION
PHASE I
EMBANKMENT

NAME OF DAM BRUSH MOUNTAIN DAM
ID# NDI 539 DER 75

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	NONE FOUND.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	NONE FOUND.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	BULGES IN DOWNSTREAM SLOPE RIPRAP (DUE TO SURFICIAL SLIDING OF RIPRAP) SOME EROSION ON DOWNSTREAM SLOPE SEE PLATE 6 FOR LOCATION.	REPAIR RIPRAP.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	NO PERCEIVABLE MISALIGNMENT	
RIPRAP FAILURES	RIPRAP SLIDES AS DISCUSSED ABOVE. RIPRAP STONES ARE SOUND	

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDG

VISUAL INSPECTION
PHASE I
EMBANKMENT
OBSERVATIONS

NAME OF DAM *BRUSH MOUNTAIN DAM*
ID# *NDT 539 DER 7-5*

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	NO SIGNS OF DISTRESS OR SEEPAGE.	
ANY NOTICEABLE SEEPAGE	SEVERAL SEEPS BELOW TOE SEE PLATE 6 FOR LOCATION.	
STAFF GAGE AND RECORDER	NONE FOUND.	
DRAINS	SEEPAGE COLLECTION SYSTEM. SEE PLATE 5	

VISUAL INSPECTION
PHASE I
CONCRETE/MASONRY DAMS

NAME OF DAM Baugh Mountain Dam
ID# NOI 539 DER 7-5

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	EARTH-FILL DAM N/A.	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	N/A.	
DRAINS	N/A.	
WATER PASSAGES	N/A.	
FOUNDATION	N/A.	

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDG

VISUAL INSPECTION
PHASE I
CONCRETE/MASONRY DAMS

NAME OF DAM *Beulah Mountain Dam*

ID# *NOT 539 DER 7-5*

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	<i>EARTHFILL DAM</i> <i>N/A.</i>	
STRUCTURAL CRACKING	<i>N/A.</i>	
VERTICAL AND HORIZONTAL ALIGNMENT	<i>N/A.</i>	
MONOLITH JOINTS	<i>N/A.</i>	
CONSTRUCTION JOINTS STAFF GAGE OF RECORDER:	<i>N/A.</i>	

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDG

VISUAL INSPECTION
PHASE I
OUTLET WORKS

NAME OF DAM BRUSH MOUNTAIN DAM
IDM NO. 539 DER 7-5

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	OUTLET CONDUIT : 2 16-INCH CAST IRON PIPE LOCATED IN DIVERSION TUNNEL. DIVERSION TUNNEL WAS <u>NOT</u> INSPECTED. (INACCESSIBLE)	
INTAKE STRUCTURE	INTAKE TOWER ACCESSIBLE BY BOAT ONLY ., NOT INSPECTED.	
OUTLET STRUCTURE	OUTLET PIPES WOULD DISCHARGE INTO A RECTANGULAR MASONRY CHANNEL	
OUTLET CHANNEL	TRAPEZOIDAL EARTH CHANNEL.	
EMERGENCY GATE	OUTLET PIPE VALVES WERE NOT OPERATED (WATER COMPANY DECLINED TO OPERATE THE VALVES WITHOUT COMPENSATION FOR SERVICES PLUS ANY DAMAGES DUE TO THE OPERATION)	

THIS PAGE IS BEST QUALITY PRACTICABLE FROM COPY FURNISHED TO DDG

VISUAL INSPECTION
PHASE I
UNGATED SPILLWAY

NAME OF DAM *Brauk Mountain Dam*
ID# *NDT 539 DER 7-5*

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	BROAD CRESTED WEIR - GOOD CONDITION	
APPROACH CHANNEL	SHALLOW - NO SIGNIFICANT OBSTRUCTIONS TO FLOW.	
DISCHARGE CHANNEL	RECTANGULAR CHANNEL. MASONRY LINING IN THE LOWER HALF IS ERODED.	
BRIDGE AND PIERS	NONE.	

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDC

VISUAL INSPECTION
PHASE I
GATED SPILLWAY

NAME OF DAM Brush Mountain Dam
ID# NOT 529 DER 7-5

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	NO GATE SPILLWAY ∴ N/A.	
APPROACH CHANNEL	N/A.	
DISCHARGE CHANNEL	N/A.	
BRIDGE PIERS	N/A.	
GATES AND OPERATION EQUIPMENT	N/A.	

VISUAL INSPECTION
PHASE I
INSTRUMENTATION

NAME OF DAM *BRUSH MOUNTAIN DAM*

100 NDI: 539 DEF: 7-5

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	NONE FOUND	
OBSERVATION WELLS	NONE FOUND.	
WEIRS	THREE SEEPAGE WEIRS AT LOCATIONS SHOWN IN PLATE. 6 WEIRS ARE <u>NOT</u> FUNCTIONAL.	
PIEZOMETERS	NONE FOUND.	
OTHER	NONE.	

VISUAL INSPECTION

PHASE 1

RESERVOIR

NAME OF DAM *Beaver Mountain Dam*

100 NOI: 529 DER: 7-5

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	WOODED, ROCKY & STEEP.	
SEDIMENTATION	UNKNOWN.	

VISUAL INSPECTION
PHASE I
DOWNSTREAM CHANNEL

NAME OF DAM *Bough Mountain Dam*
ID# *NDI: 539 DER: 1-5*

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	ROCKY AND STEEP TYPICAL MOUNTAIN STREAM CHANNEL.	
SLOPES	NARROW VALLEY DOWNSTREAM TO POTTSGROVE RESERVOIR. CHANNELIZED IN SEGMENTS BELOW POTTSGROVE RESERVOIR.	
APPROXIMATE NUMBER OF HOMES AND POPULATION	EAST END OF ALTOONA. ABOUT 100 HOME, NUMEROUS COMMERCIAL AND LIGHT INDUSTRIAL BLDGS. POPULATION 1000 AND OVER.	

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDG

APPENDIX B
CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

40

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM BRUSH MOUNTAIN DAM
ID# NOT 539 DER.7-5

ITEM	REMARKS
AS-BUILT DRAWINGS	NO ORIGINAL DRAWINGS ARE AVAILABLE.
REGIONAL VICINITY MAP	SEE PLATE 1
CONSTRUCTION HISTORY	BUILT IN 1888. DAM RECEIVED MAJOR REPAIRS IN 1912. SPILLWAY CHANNEL WAS REPAIRED IN 1928 & 1936.
TYPICAL SECTIONS OF DAM	SEE PLATE 2.
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINGS	NOT AVAILABLE.

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDC

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM *Bruck Mountain Dam*
ID# *NDI 539 DCR 75*

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	NOT AVAILABLE.
DESIGN REPORTS	NOT AVAILABLE
GEOLOGY REPORTS	NOT AVAILABLE
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	NOT AVAILABLE
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	NOT AVAILABLE

**THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDG**

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Braun Mountain Dam
ID# NOT: 539 DER: 7-5

ITEM	REMARKS
POST CONSTRUCTION SURVEYS OF DAM	NONE REPORTED.
BORROW SOURCES	UNKNOWN
MONITORING SYSTEMS	SEEPAGE MONITORING SYSTEM BELOW TOE. NOT FUNCTIONAL.
MODIFICATIONS	DAM WAS REPAIRED 1912 TO STOP SEEPAGE AROUND ABUTMENTS.
HIGH POOL RECORDS	NOT AVAILABLE. ACCORDING TO A STATE REPORT DATED MAY 14, 1936. DEPTH OF FLOW OVER THE SPILLWAY WAS 2.1 FT.

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDG

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Lower Mountain Dam
100 NDI 539 DER 7-5

ITEM	REMARKS
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	NONE REPORTED OTHER THAN PERIODIC STATE INSPECTION REPORTS.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	NONE REPORTED.
MAINTENANCE OPERATION RECORDS	NOT AVAILABLE.
SPILLWAY PLAN SECTIONS DETAILS	SEE PLATES 3 AND 4
OPERATING EQUIPMENT PLANS AND DETAILS	NOT AVAILABLE.

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDG

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDQ

NAME OF DAM BRUSH MOUNTAIN DAM

ID# NDI 529 DER: 1-5

CHECKLIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: WOODED, (2.5 SQ. MILES)

ELEVATION; TOP NORMAL POOL AND STORAGE CAPACITY: 577 AC-FT @ EL. 1718

ELEVATION; TOP FLOOD CONTROL POOL AND STORAGE CAPACITY: SAME AS ABOVE

ELEVATION; MAXIMUM DESIGN POOL: EL 1718 (USGS DATUM)

ELEVATION; TOP DAM: EL 1723

CREST: (SPILLWAY)

- a. Elevation EL. 1718
- b. Type BROAD CRESTED CHUTE SPILLWAY
- c. Width 54 - FT
- d. Length -
- e. Location Spillover AROUND LEFT ABUTMENT
- f. Number and Type of Gates NONE

OUTLET WORKS:

- a. Type 2 - 16-INCH CAST IRON PIPES
- b. Location THROUGH DIVERSION TUNNEL
- c. Entrance Inverts UNKNOWN
- d. Exit Inverts EL 1670 (ESTIMATED)
- e. Emergency Draindown Facilities 2 - 16-INCH PIPES.

HYDROMETEOROLOGICAL GAGES:

- a. Type NONE
- b. Location NONE
- c. Records NONE

MAXIMUM NONDAMAGING DISCHARGE: ABOUT ~ 500 CFS.
(OVER TOPPING OF FIRST DOWNSTREAM
BRIDGE)

APPENDIX C
PHOTOGRAPHS

LIST OF PHOTOGRAPHS
BRUSH MOUNTAIN DAM
JULY 10, 1978

<u>PHOTOGRAPH NO.</u>	<u>DESCRIPTION</u>
1	Crest (looking south).
2	Spillway discharge channel.
3	Outlet works.
4	Seepage from outlet works and left abutment.
5	Seepage from right abutment.
6	Distribution reservoir (one mile downstream).
7	Pottsgrove Reservoir spillway.
8	Bridge on Route 220
9	Typical stream channel (through Altoona).
10	Little Juniata River (Kettle Creek discharges through a 5-foot CMP).



Photograph No. 1
Crest (looking south).



Photograph No. 2
Spillway discharge channel.



Photograph No. 3

Outlet works.



Photograph No. 4

Seepage from outlet works and left abutment.



Photograph No. 5
Seepage from right abutment.



Photograph No. 6
Distribution reservoir (one mile downstream).



Photograph No. 7
Pottsgrove Reservoir spillway.



Photograph No. 8
Bridge on Route 220.



Photograph No. 9
Typical stream channel (through Altoona).



Photograph No. 10
Little Juniata River (Kettle Creek
discharges through a 5-foot CMP).

APPENDIX D
CALCULATIONS

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDG

D'APOLONIA

CONSULTING ENGINEERS, INC.

By UTC Date 7-17-78 Subject BRUSH MOUNTAIN DAM Sheet No 1 of 2
Chkd. By BE Date 7-25-78 HYDROLOGY & HYDRAULIC Proj. No. 78-14-17

DAM BRUSH MOUNTAIN DAM

WATERSHED AREA $A = 2.5 \text{ SQ. MILE}$

THE DAM IS LOCATED IN SUSQUEHANNA BASIN, REGRIN NO 1

ACCORDING TO THE CHARTS PROVIDED BY COE, BALTIMORE DIST

PEAK INFLOW $q = 3450 \text{ cfs/SQ MILE}$

$$Q = q A = 8625 \text{ cfs} \quad \boxed{\text{say } 8600 \text{ cfs}}$$

TOTAL TIME $T = 22 \text{ HOURS}$

VOLUME OF INFLOW

$$\begin{aligned} V_1 &= \frac{1}{2} (T)(Q) \\ &= \frac{1}{2} (22 \times 8600)(8600) \left(\frac{1}{43560} \right) \\ &= 7818 \text{ AC-ft} \end{aligned}$$

WHICH IS EQUAL TO $59''/22 \text{ hr}$. REVISED TO $26''$ RUNOFF

$$V_1 = \frac{26}{12} \times 2.5 \times 640 = 3467 \quad \boxed{\text{say } 3500 \text{ ac-ft}}$$

$$t_{26} = \frac{3500 \times 43560}{\frac{1}{2} (3600)(8600)} = 9.8 \text{ hours}$$

RESERVOIR SURCHARGE STORAGE ABOVE SPILLWAY EL 1717.

$$\begin{aligned} V_R &= \overset{\text{AUG. LAKE AREA}}{36 \text{ ac}} \times \Delta H = 36 \times 5 \quad \leftarrow \text{measured in field} \\ &= 180 \text{ ac-ft} \end{aligned}$$

D'APPOLONA
CONSULTING ENGINEERS, INC.

By WTC Date 7-17-78 Subject BRUSH MOUNTAIN DAM Sheet No 2 of 2
Chkd By BE Date 7-25-78 HYDROLOGY Proj. No 78-14-17

SPILLWAY CAPACITY

$$\begin{aligned} Q_s &= C L H^{1.5} \\ &= (2.6)(54)(5)^{1.5} \\ &= 1570 \text{ cfs} \end{aligned}$$

ESTIMATE PERCENT OF PMF WITHOUT OVERTOPPING

$$\begin{aligned} &= \left(\frac{1570}{8600} + \frac{180}{3500} \right) 100\% \text{ PMF} \\ &= 23\% \text{ PMF} \end{aligned}$$

DETERMINE the WATER DEPTH h OVERTOP DAM

approximate:

$$\begin{aligned} \text{TOTAL DISCHARGE CAPACITY} &= (2.6)(54)(5+h)^{1.5} + (2.6)(800)(h)^{1.5} \\ &= 140(h+5)^{1.5} + 2080h^{1.5} \end{aligned}$$

$$\text{STORAGE VOL} = 36(h+5)$$

then:

$$\frac{140(h+5)^{1.5} + 2080(h)^{1.5}}{8600} + \frac{36(h+5)}{3500} = 1$$

$$\begin{aligned} h &= 1.90 \text{ ft} \\ Q &= 7985 \text{ cfs} \quad \boxed{\text{say } 8000 \text{ cfs}} \end{aligned}$$

APPENDIX E
REGIONAL GEOLOGY

APPENDIX E

REGIONAL GEOLOGY

The Brush Mountain Dam is located in the Appalachian Mountain Province just east of the Appalachian Front. This province is an area of strata that have been folded in a series of anticlines and synclines with some faulting. The dam is on the nose of a southwest plunging anticline. The east limb of this anticline dips relatively steeply, while the west limb is nearly vertical. This fold contains a thrust fault (with the fault plane dipping to the southeast) along the axis of the fold north of the reservoir. Although there is no evidence of faulting in the vicinity of the dam, the axis of the fold has a fracture system parallel to the trend of the fold (i.e., northeast). In addition, a secondary fracture system trends east-northeast, perpendicular to the fold axis.

The rock type in the vicinity of the dam is the Ordovician Age Juniata Formation, a hard thin-bedded red sandstone with some interbedded shale. The Juniata Formation is highly resistant to weathering and forms moderately steep slopes.